EVALUATION OF THE NEXT-GEN EXERCISE SOFTWARE INTERFACE IN THE NEEMO ANALOG

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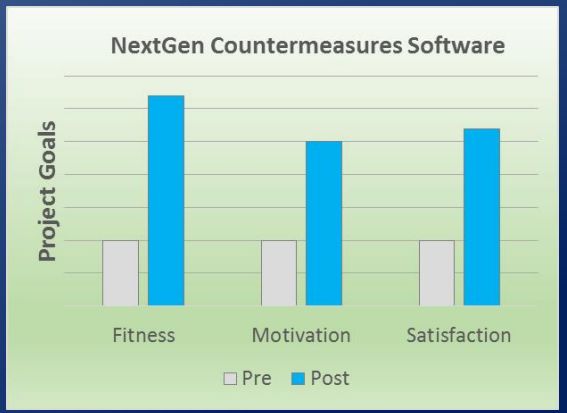
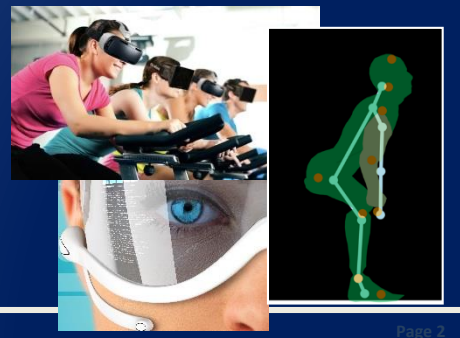
Background

- **NSBRI funded research grant to develop the 'NextGen' exercise software.**
  - Develop a software architecture to integrate instructional, motivational and socialization techniques into a common portal to enhance exercise countermeasures in remote environments.
  - Increase user efficiency and satisfaction, and institute commonality across multiple exercise systems.
  - Utilized GUI design principals focused on intuitive ease of use to minimize training time and realize early user efficiency.
  - Project requirement to test the software in an analog environment.



- **Top Level Project Aims**

1) Improve the usability of crew interface software to exercise CMS through common app-like interfaces.
2) Introduce virtual instructional motion training.
3) Use virtual environment to provide remote socialization with family and friends, improve exercise technique, adherence, motivation and ultimately performance outcomes.



Miniature Exerice Device- Second Generation (MED-2)

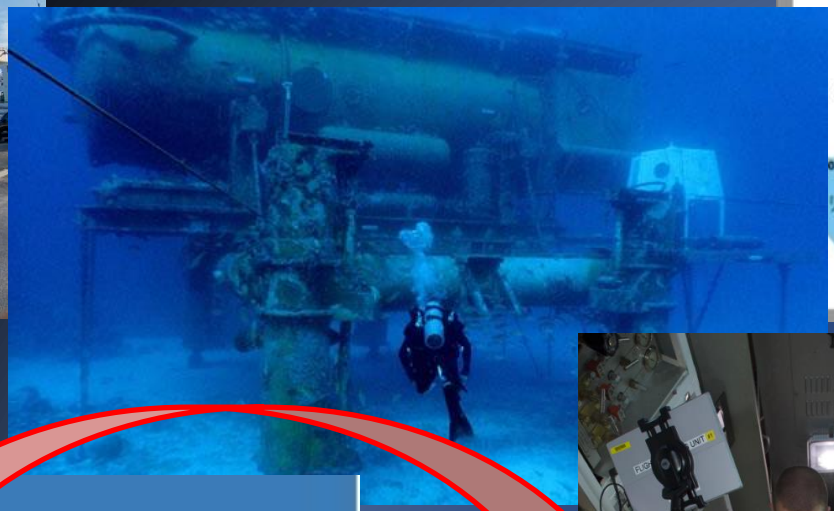
- The MED-2 is a small exercise device selected under the 2 x 2015 1E process to expedite fabrication and launching new International Space Station (ISS) hardware.
- The MED-2 will be used on the ISS as a test bed for understanding small exercise device capabilities and informing future Multi-Purpose Crew Vehicle exercise device designs.
- MED-2 is currently aboard the ISS.
  - First crew session planned for February 2017.
  - Valuable lessons learned from NEEMO21 evaluation provide direct benefit to ISS evaluation.

NASA Extreme Environment Mission Operations
NEEMO

- **The NEEMO analog provides:**
  - A trained, international crew (astronauts and civilian), N=6, to carry out research objectives.
  - Mission days fashioned after ISS work plan.
  - A trained mission operations team in a functional Mission Control Room (Mission Director, Ops Lead, Schedule Lead, Capcom and use of flight-like communication tools and protocols, etc.).
  - Opportunity for work-volume assessment in a small footprint habitat.
  - A true extreme and remote test environment.
  - Dry-run of in-flight protocols and procedures.
  - Overall one of the most valuable analog and flight readiness test facilities available.

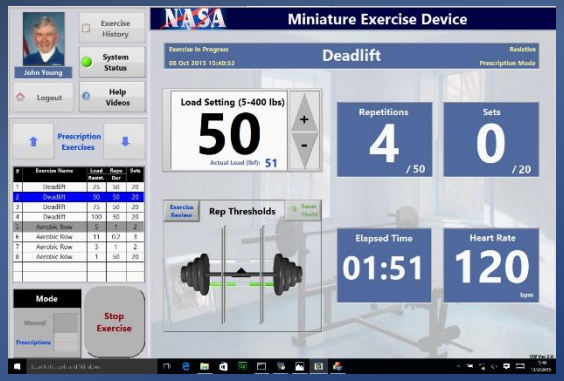
Aquarius Reef Base

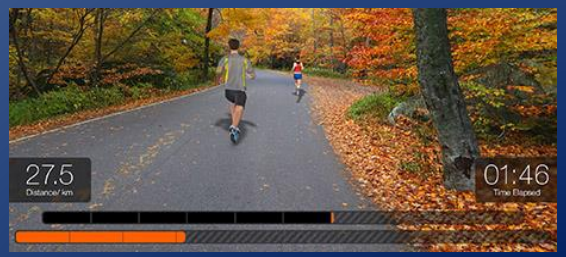
Aquarius is located ~9 miles south of Key Largo, FL at ~60 feet deep.



NEEMO21 Goals

- **Evaluate NextGen SW with the MED-2 exercise device to assess user efficiency and satisfaction.**
  - User satisfaction surveys post sessions.
  - Usability testing software (Morae) records each screen session and allows assessment of user efficiency.
  - Test feasibility of using the virtual interface and training partner (Run Social) with a remote user.
  - Solicit feedback on use of MED-2 hardware.





Mission Control and NextGen Ops

	MD1	MD2	MD3	MD4	MD5	MD6	MD7	MD8
Crew 1		14:30-15:15 Strength		15:45-16:30 Aerobic		15:30-16:15 Strength-Aero		
Crew 2			14:45-15:30 Strength		16:30-17:15 Aerobic		14:30-15:15 Strength-Aero	
Crew 3			16:00-16:30 Strength		14:30-15:15 Aero-RunSocial		15:15-16:00 Strength-Aero	
Crew 4		15:15-15:45 Strength		14:30-15:15 Aero-RunSocial		16:15-17:00 Strength-Aero		

	MD9	MD10	MD11	MD12	MD13	MD14	MD15	MD16
Crew 1			15:00-15:45 Strength-Aero			15:15-16:00 Aero-RunSocial		
Crew 2		16:00-16:45 Strength-Aero			16:45-17:30 Aero-RunSocial			
Crew 5		15:15-16:00 Strength-Aero		14:30-15:15 Strength		14:30-15:15 Aero-RunSocial		
Crew 6			15:45-16:15 Strength-Aero	17:00-17:45 Strength	16:00-16:45 Aero-RunSocial			

NEEMO21: Evaluation of NextGen Software on MED-2

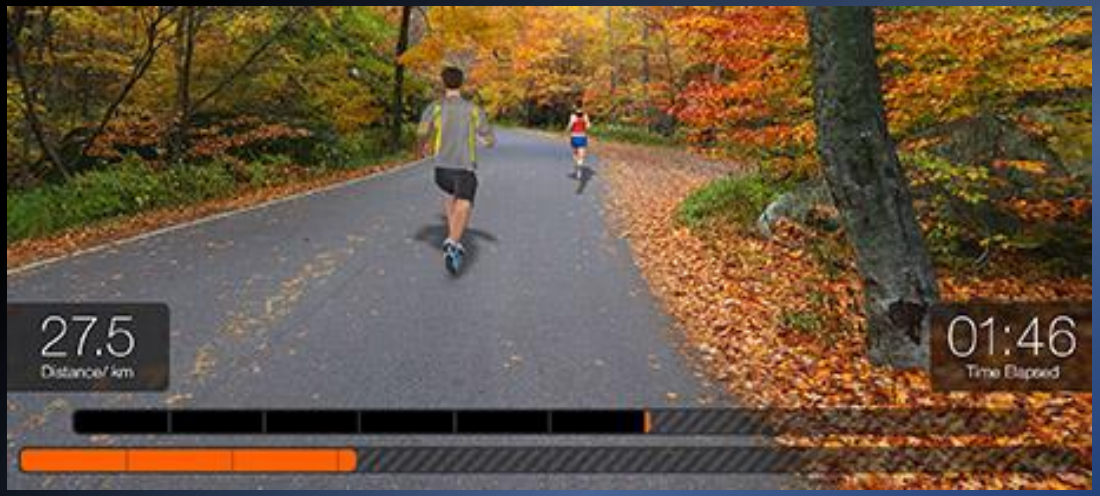
- NextGen software runs on a Microsoft Surface Pro platform.

MED Login View

Resistive MED View

#	Exercise Name	Load Resist.	Reps Dur	Sets
1	Deadlift	25	50	20
2	Deadlift	50	50	20
3	Deadlift	75	50	20
4	Deadlift	100	50	20
5	Aerobic Row	5	1	2
6	Aerobic Row	11	0.2	3
7	Aerobic Row	3	1	2
8	Aerobic Row	1	50	20

Run Social



- RunSocial.com actual environments and socialization techniques will be evaluated as an integrated feature to the new CMS software system.

- These features will enable crew members to select daily running/rowing virtual environments with changing landscapes that match the exercise prescription provided by the astronaut strength and conditioning coaches (i.e. speed, etc).

- For NEEMO21 evaluation, upright rowing will be substituted for running, and you will be connected to a virtual training partner located topside.
  - RunSocial displayed on iPad, not the Surface Pro.

System Usability Assessment

Morae® Analysis (~20 hours of video)

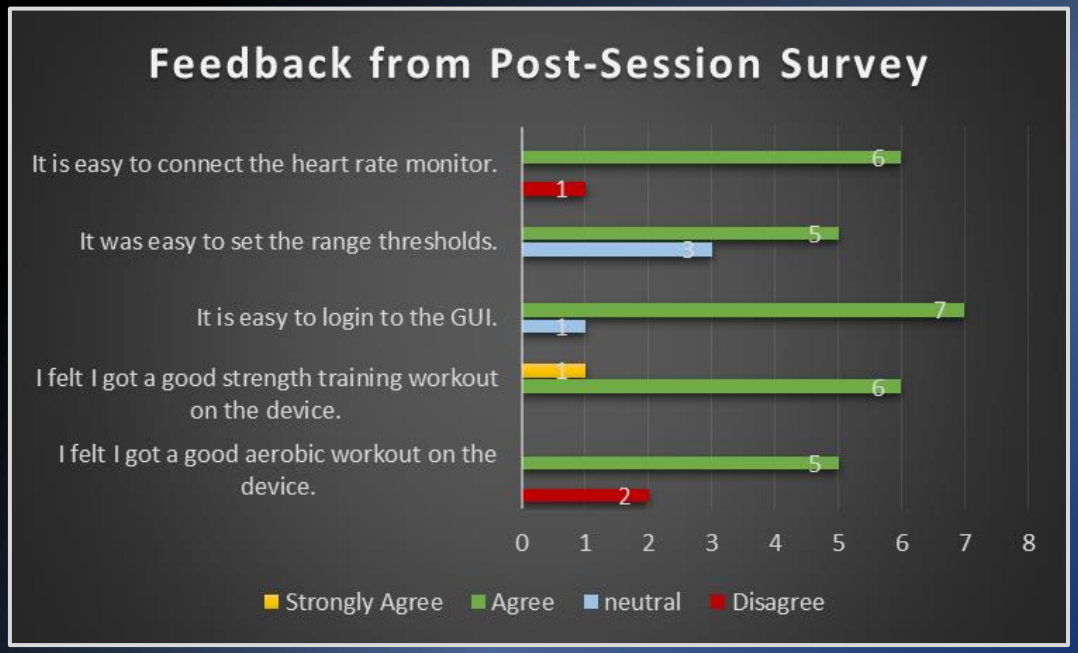
- Allows you to record and remotely observe user interactions (navigation through software screen only) and audio recording for analysis of in-session commentary.

Key Feedback Captured

- Connectivity issues sometimes resulted in failure to transfer exerciser protocols, pop-up of post-session survey, and transfer of data files.
- Revealed the exercise demonstration videos were in a bad location.
- It was not clear how to navigate through the Rx list.
- The Bluetooth Heart Rate Monitor was difficult to pair.
- Server issues disrupted synchronization of data files.
- Exercise threshold settings need higher tolerance to capture all repetitions performed.
- Great crew-to-crew training and shared experience.
- Get rid of need to select start/stop at each new set.

- *"This is a pretty legit workout!"*
- *"You have to hit end/start exercise every time and I found that very annoying."*
- *"That doesn't seem to work." (paired with screen interaction provided flag on specific issue-selecting exercise in list vs using navigation arrows)*

System Usability Assessment



- 50% response rate (11/22).
- Server disruptions resulted in cancelation of survey at end of session. Fixed with sw update.
- Generally an overall positive response on system usability and utility.

•Post-Session Survey Written Feedback

- Label cables. Instructions were not clear in setup. Error screens and flow were not accounted for.
- Setup was cumbersome. Once I got exercising, most things were intuitive. Not sure why I need to select stop exercise and start in between each sets that should be automatic
- First time user with limited training, there should be pictures or video to demonstrate how to do each exercise properly with this device. The help videos are empty and there are no images in the referenced procedure.
- If I skip an exercise, I still have to scroll past it each time I finish a subsequent exercise. The next exercise in the list should be the default.
- Heart rate monitor is easily paired but did not display anything. No joy with a 2nd heart rate monitor.
- The exercise prescription should follow one after the other with a 30-60 second break between sets.

Crew Debrief & Lesson Learned

Safety Notes:

– Need to review the mechanism for emergency release of a loaded bar.

– Crew reported it was difficult to get a loaded bar in place for front squat.

Actions:

– Added caution block to ISS Procedures alerting crew to the fact that the cable will pull in if/when released.

– Demonstration and familiarity with the cable release action will be added to the ground training session.

– Crew are reminded exercise in zero-gravity is different from ground training, and to not perform any exercise they feel poses a safety concern.

GUI Notes:

– Crew provided feedback on the desire to see the software auto iterate between sets of the same exercise.

Actions:

– Videos can be sent up at any time without making changing to the flight software.

– All videos that demonstrate exercise form will be included in the 'Exercise Review' button, and procedures note how to find these videos.

– The button 'Exercise Review' will be renamed to 'Exercise Video' to alleviate confusion over where to locate the exercise videos.

Crew Debrief & Lesson Learned cont.

- Additional vetting of exercise procedures in an ISS analog environment resulting in enhanced ISS MED 2 procedures.
- Redefined scheduling of hardware setup and teardown timeline. NEEMO analog environment/crew consistently showed hardware setup and teardown took longer than originally planned.
- Allow more time for operations in timeline/PlayBook (most of our sessions were not completed within allocation – set up and tear down took much longer than expected, probably help videos would have been much more useful in make the process more efficient).
- Identified shortcoming of the MED 2 heart rate monitor Bluetooth paring with the Microsoft Surface Pro 3.
- Additional training/simulation opportunity for MED 2 ISS ops and engineering support teams.
- Software development goal is to minimize training needs, through an intuitive App-like interfaces. NEEMO crew commented that the SW was intuitive and easy to use. Continue to assess how this goal has been achieved.
- Leverage video help screens vs textual/graphical help files or crew procedures (use short targeted videos) - we didn't have enough of these videos pre-developed.
- Highlighted need for flexibility to change operational parameters and configurations, setups, questionnaires remotely (already incorporated).

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